

# NOAA Technical Memorandum NMFS

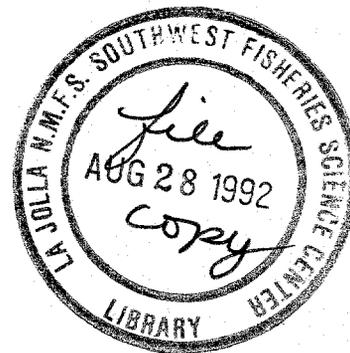


JULY 1992

**A PROGRAM FOR THE MICROSOFT® WINDOWS™  
ENVIRONMENT TO COLLECT ANALOG-TO-DIGITAL  
AND SERIAL COMMUNICATION DATA ON  
A PERSONAL COMPUTER BASED SYSTEM**

Robert C. Holland

NOAA-TM-NMFS-SWFSC-170



U.S. DEPARTMENT OF COMMERCE  
National Oceanic and Atmospheric Administration  
National Marine Fisheries Service  
Southwest Fisheries Center

## NOAA Technical Memorandum NMFS

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# A PROGRAM FOR THE MICROSOFT® WINDOWS™ ENVIRONMENT TO COLLECT ANALOG-TO-DIGITAL AND SERIAL COMMUNICATION DATA ON A PERSONAL COMPUTER BASED SYSTEM

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## INTRODUCTION

PCPluss for Windows and the companion programs were developed to sample continuous and discrete data from a variety of environmental sensors during transits of a research vessel; it was specifically designed for the Pacific research cruises: MOPS (Monitoring Of Porpoise Stocks), PODS (Population Of Delphinus Stocks), and CAMMS (California Marine Mammal Survey), to use an inexpensive personal computer (PC), but it also has potential use in any R/V oceanographic program due to its inherent expandability and adaptability.

PCPluss for Windows is a Visual Basic<sup>1</sup> program designed to sample, average and store multiple streams of data from a variety of sources. It is presently configured to directly use an AIO8-B<sup>2</sup> analog-to-digital (A/D) board and convert analog data from a Turner Designs<sup>3</sup> fluorometer (flow-thru Model 10) to a 12-bit digital form, collect temperature and salinity data from a Sea-Bird<sup>4</sup> thermosalinograph through a communication port, and to collect satellite navigation (GPS, LORAN, SATNAV) latitude and longitude locations through a second communication port. It is also possible to reconfigure the system to sample from other types of sensors.

The input data are averaged and stored in an ASCII data format. Data are collected at one-second intervals and averaged over two minutes (default). The data file is opened only when data are to be written, thereby safeguarding data integrity from power loss or equipment failure. The AIO8-B is an 8-bit, XT style board that uses an expansion slot in a PC. The AIO8-B can be attached to an EXP-16<sup>2</sup> multiplexer board through an external cable to allow multiple analog inputs.

The EXP-16 can be cascaded with seven other multiplexer boards to provide a maximum of 128 current or voltage analog inputs. Currently only three analog inputs are received through the EXP-16 board as fluorometer voltage, and two for fluorometer scale. PCPluss for Windows can only operate two communication ports (COM1 and COM2) at once due to the constraints of the PC interrupt architecture.

Because the Windows<sup>1</sup> 3.1 environment is used, an 80386SX-16 processor should be the minimum processor used in the PC. The personal computer currently used for PCPluss for Windows is an 8533-RV<sup>2</sup> rack mount chassis with a 12"-VGA monitor and 10-slot backplane. The processor board is an SB386SX/16-4<sup>2</sup> with a 16 megahertz (Mhz.)

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<sup>1</sup>Windows 3.1 and Visual Basic 1.0. Copyright Microsoft Corp.

<sup>2</sup>Industrial Computer Source, San Diego, CA. 92123.

<sup>3</sup>Turner Designs, Mountain View, CA. 94043.

<sup>4</sup>Sea-Bird Electronics, Inc. Bellevue, WA. 98005.

Intel 80386SX processor, IIT 387SX-16 math coprocessor, 4 megabytes (MB) of RAM, and two serial ports (RS-232). A Quatech DS202/DS302<sup>5</sup> asynchronous serial RS-422 board is also used to receive position data from a GPS with the NEMA standard (with one RS-422 port disabled and one RS-232 port disabled so only two serial ports remain). The rack mount chassis is a fully enclosed unit with positive air flow through filters covering two fans to keep dust and salt intake to a minimum. Also, a membrane type keyboard is used to protect against environmental conditions. A 50 MB Plus Hardcard II XL<sup>6</sup> is used as the main storage device.

## PCPLUS FOR WINDOWS

The following files are necessary for the operation of PCPlus for Windows:

INSTALL.EXE	- Installs the necessary files, group window and icons
INSTALL.INF	- Contains the file names to install
PCPLUS.EXE	- The main program
PACIFIC.BMP	- A clean file of the Eastern Tropical Pacific (ETP)
MAP.BMP	- The ETP with current track lines
VBRUN100.DLL	- Visual Basic run-time library
COMMTEST.EXE	- Communication port test program
PDQCOMM.DLL	- Library for communication port routines
AIO8DLL.DLL	- Library for AIO8-B routines
TXTWND.VBX	- Library for COMMTEST text display
DINSTALL.EXE	- De-installs all files created by INSTALL and PCPLUS

A PCPLUS.INI file is created in the Windows directory which stores all variable information for program configuration.

## OPERATION

When PCPlus for Windows is started, Standard Mode (Sampling) is operating during data acquisition. The date, time, latitude, longitude, heading, speed, temperature, salinity, fluorometer voltage, and fluorometer scale are constantly shown and updated. The

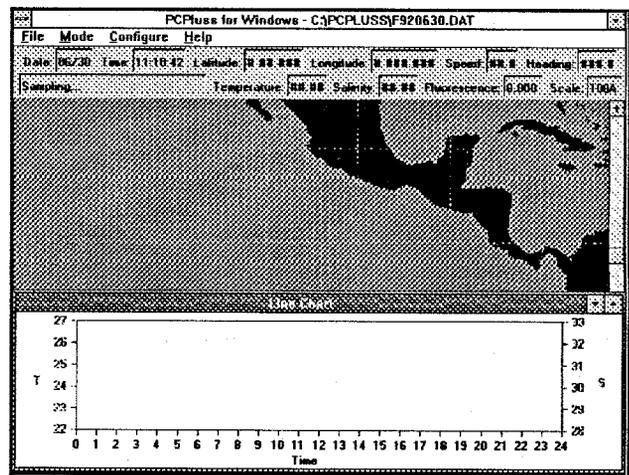


Figure 1

<sup>5</sup>Quatech, Inc, Akron, OH. 44311.

<sup>6</sup>Plus Development Corporation, Milpitas, CA. 95035-7421.

output data file name is shown with the program title on the full screen window display.

Figure 1 shows the normal operation of PCPlus for Windows with cruise track map and temperature/salinity chart. The cruise track map ranges from 50° North to 20° South and 160° West to 70° West. Each grid square is 10°x10°. The TempSal chart has the x-axis as time from 0 to 24 hours. The left y-axis is the temperature scale and the right y-axis is the salinity scale, each of which can be adjusted by the Configure pull-down menu. If the fluorometer routine is enabled, the Mode pull-down menu has a Suspend Mode to allow either a Blank value to be recorded (30 seconds of sampling of a discrete water sample) or to mark a record for calibration against a discrete sample (Smith et al., 1981). While in Suspend Mode, all sampling is disabled until a proper mode is enabled or restarted.

The menu bar is divided into four menus: File Menu, Mode Menu, Configure Menu, and Help Menu (see figure 1). The File Menu contains the New Map and Exit items. The New Map item will allow you to clear the map display of all cruise track lines by loading in a new map. Exit will close all files and modules and end the program.

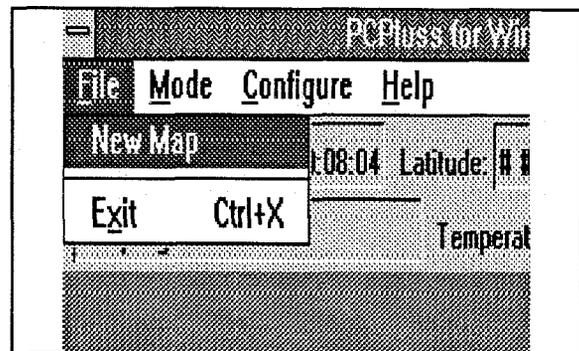


Figure 2

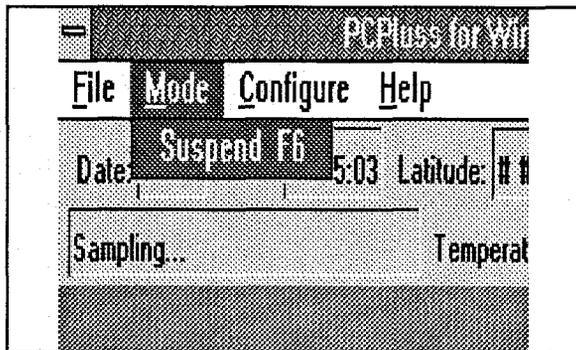


Figure 3

The Mode Menu contains the Suspend item, which will only be active if the fluorometer routine is enabled. This item will suspend all data acquisition for blanking and cleaning of the fluorometer.

The Configure Menu contains the COM Ports, Digital I/O, Line Chart, and Initialization File configuration items. COM Ports configure item allows you to adjust the serial ports' baud rate, parity and stop bits. Digital I/O configure item permits you to alter the AIO8-B data address port as well as the port values of the connections on the

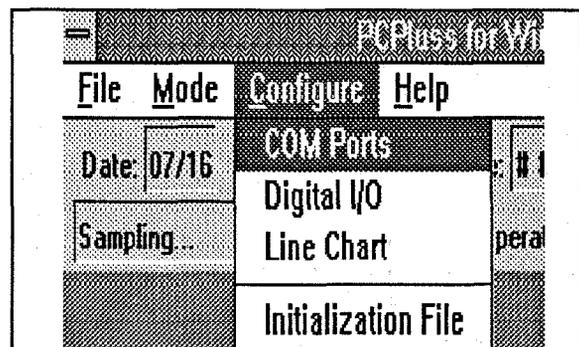


Figure 4

EXP-16. Line Chart configure item enables you to adjust the scale values for the temperature and salinity. If a range of five degrees (between high and low) is set for the temperature scale, a range of five degrees will be used when the line chart has to shift the high and low values to accommodate input values outside the initial range. Initialization File configure item allows you to save all current PCPlus variable values to the initialization file (PCPLUS.INI) stored in the Windows directory. When PCPlus for Windows is started again, all startup values will be the same as before. This is necessary if a serial port baud rate is changed to a new permanent value that was different than when PCPlus for Windows was installed. This item will allow you to change a variable's value that is saved to the initialization file, but will not change current value of that variable while PCPlus is running (this must be done by the three Configure items).

The Help Menu contains the Help and About items. The Help item contains all of the information necessary to use PCPlus for Windows and is compatible with the Help file format. The About item lists the version number and author.

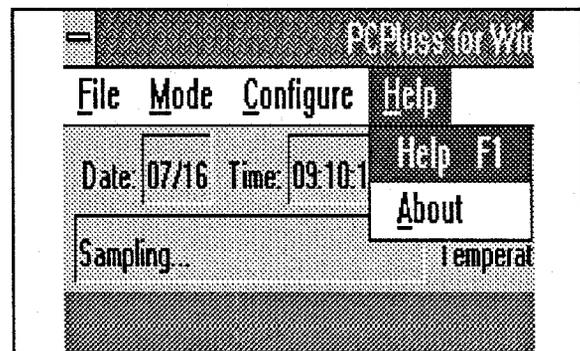


Figure 5

### PCPLUS OUTPUT

Data are stored in a sequential ASCII format in the PCPlus directory. When the PC clock increments to the next date, a new data file is created with the date as the file name. If the fluorometer routine is enabled, a data line would contain 71 characters (including carriage return and line feed). A full day's worth of data would be about 50 Kb. Therefore, a 30-day period would consume about 1.5 Mb of harddisk space. If the fluorometer routine is disabled, a data line would contain 62 characters, a day's amount of data would be about 43.5 Kb, and a 30-day period would consume about 1.3 Mb of disk space. During a full 120 day MOPS cruise in the Eastern Tropical Pacific (ETP) with the fluorometer routine enabled, at least 6 Mb of disk space should be available for the data. The following data are an excerpt from a data file of a California coastal cruise in 1992 with the fluorometer routine disabled. Shown are the date, time, latitude, longitude, temperature, salinity, speed, heading (magnetic), and mode. The file name for the following data would be: F920513.DAT (F for file, 920513 for date).

```
05/13 00:01:31 N 36.582 W 122.034 13.51 32.50 01.9 183.9 |
05/13 00:03:31 N 36.582 W 122.037 13.53 32.48 05.1 253.0 |
05/13 00:05:31 N 36.583 W 122.039 13.54 32.48 05.3 266.8 |
05/13 00:07:31 N 36.583 W 122.041 13.55 32.48 05.6 255.7 |
```

05/13 00:09:31 N 36.583 W 122.043 13.58 32.47 05.7 251.3 |  
05/13 00:11:31 N 36.583 W 122.045 13.61 32.47 05.2 252.5 |  
05/13 00:13:31 N 36.583 W 122.047 13.61 32.48 04.9 250.2 |  
05/13 00:15:31 N 36.582 W 122.049 13.63 32.47 05.3 249.2 |

## PCPLUS INITIALIZATION

The default initialization settings recorded in PCPLUS.INI are:

DIRECTORY=C:\PCPLUS  
SAMPLE=120  
BLANK=30  
COM1=9600,N,8,1  
COM2=4800,N,8,1  
TEMPSAL=^10,1,5,7,5,14  
SATNAV=\$GPGLL,7,2,9,5,15,1,17,3,20,5,26,1,75  
LINECHART=1  
TEMPSALCOM=1  
TEMPLOW=22  
TEMPHIGH=27  
SALLOW=28  
SALHIGH=33  
BASEADDR=768  
GAIN=2  
FLUOROMETER=1  
FLUORPORT=1  
FLUORABCD=0  
FLUORX100=2

All of the following variables (except Directory) can be set by the Initialization item of the Configure menu in PCPlus for Windows.

**DIRECTORY** shows the location of the PCPlus files and programs. This statement is set during installation of PCPlus for Windows.

**SAMPLE** is the number of seconds to sample and average data before writing the data to disk.

**BLANK** specifies the number of seconds for each discrete blank recording.

**COM1** contains the baud rate, parity, number of data bits, and number of stop bits for the COM1 serial port.

**COM2** contains the baud rate, parity, number of data bits, and number of stop bits for the COM2 serial port.

**TEMPSAL** contains the parse values to decode the input string from the thermosalinograph.

**^10, 1, 5, 7, 5, 14**  
1 2 3 4 5 6

1. The search string for PCPlus to locate to signify the start of the temperature and salinity (the ^ means the next two characters are an ASCII value from 00 to 31).
2. The number of characters after the start of the search string where the temperature starts.
3. The number of characters representing the temperature.
4. The number of characters after the start of the search string where the salinity starts.
5. The number of characters representing the salinity.
6. The total number of characters representing one line of TempSal output.

**SATNAV** contains the parse values to decode the input string from the GPS or SATNAV.

**\$GPGLL, 7, 2, 9, 5, 15, 1, 17, 3, 20, 5, 26, 1, 75**  
1 2 3 4 5 6 7 8 9 10 11 12 13 14

1. The search string for PCPlus to locate to signify the start of the latitude and longitude (a ^ followed by two numbers represents an ASCII value from 00 to 31).
2. The number of characters after the start of the search string where the latitude degrees start.
3. The number of characters representing the latitude degrees.
4. The number of characters after the start of the search string where the latitude minutes start.
5. The number of characters representing the latitude minutes.
6. The number of characters after the start of the search string where the north/south indicator starts.
7. The number of characters representing the north/south indicator.
8. The number of characters after the start of the search string where the longitude degrees start.
9. The number of characters representing the longitude degrees.
10. The number of characters after the start of the search string where the longitude minutes start.
11. The number of characters representing the longitude minutes.
12. The number of characters after the start of the search string where the east/west indicator starts.
13. The number of characters representing the east/west indicator.
14. The total number of characters representing one SATNAV output string.

**LINECHART** equals 1 if the line chart is enabled, 0 if the line chart is disabled.

**TEMPSALCOM** equals 1 if the thermosalinograph is connected to COM1, 0 if the GPS or SATNAV is connected to COM1.

**TEMPLOW** and **TEMPHIGH** are the respective initial low and high values for the temperature scale on the line chart.

**SALLOW** and **SALHIGH** are the respective initial low and high values for the salinity scale on the line chart.

**BASEADDR** is the base address of the AIO8-B A/D board (in decimal format).

**GAIN** is the gain setting on the EXP-16 board.

**FLUOROMETER** equals 1 if the fluorometer is enabled, 0 if disabled.

**FLUORPORT** is the port number on the EXP-16 board where the fluorometer voltage input is attached.

**FLUORABCD** is the port number on the EXP-16 board where the fluorometer analog range input is attached.

**FLUORX100** is the port number on the EXP-16 board where the fluorometer digital x1/x100 knob input is attached.

## **PCPLUS COMPONENTS**

PCPlus for Windows requires certain components to gather information. The following components are currently necessary for proper data sampling. The EXP-16 and AIO8-B components (fluorometer) are optional and the program interface for the fluorometer can be disabled during installation or reconfigured during run-time operation.

### **Satellite Navigation**

PCPlus for Windows will work with a standard GPS (Global Positioning System)/Omega, Loran, SATNAV, or a GPS with the NEMA standard. The current installation program is set to recognize a NEMA standard GPS. The current GPS/NEMA standard transmits serial data over an RS-422 port instead of the commonly used RS-232. Therefore, an RS-422 board will be necessary. Most serial boards come with two ports, so the second port on the RS-422 board and the second port on the RS-232 board will need to be disabled. Reconfigure the remaining RS-422 port to COM2 (interrupt request 3 (IRQ3), and port address 2F8-2FF) and retain this information during installation of PCPlus for Windows.

## EXP-16

The EXP-16 has eight channels (0 - 7) which can be multiplexed through the AIO8-B board. Each channel has "signal hi" and "signal lo" inputs for devices with grounded signals. Also, there is an EXP-16 ground associated with each channel for floating signals (all fluorometer inputs have grounded (return) signals). There may need to be a load resistor across each "hi" and "lo" channel to scale each input signal to a proper voltage range (input signal times gain must be within -5 to 5 volts).

Each channel is then multiplexed through gain circuitry for input signal amplification. The EXP-16 has eight gain settings: 0.5, 1, 2, 10, 50, 100, 200, and 1000. Since the fluorometer inputs are in the range 0 - 1 volt, a gain setting of 2 can be used for each signal (since the AIO8-B can only digitize -5 to 5 volts, a gain setting >2 cannot be used).

## AIO8-B

There are three channels currently being used by the AIO8-B on the EXP-16: 0) Fluorometer Scale, 1) Fluorescence Voltage, and 2) Voltage of x1/x100 knob. All channels have inputs ranging from 0 to 1 volt. Thus, the calculations in the program for the on-screen and in-file data are calculated as shown in equation 1:

$$INPUT[volts] = \frac{INPUT[digital] * \frac{5 [volts]}{2048 [digital]} - 5}{GAIN} \quad (1)$$

The values retrieved from the AIO8-B board is in digital form representing a 10 volt range (= 12 bits). This number is then multiplied by 5 (volts) and divided by its digital equivalent 2048 (to put the equation into a volt unit). This value is then subtracted by 5 to put the whole equation into a -5 to 5 volt range and then the entire equation is divided by the gain setting on the EXP-16 board to represent the actual input voltage on the EXP-16 as shown in table 1:

Table 1:

Binary	Hexadecimal	Analog Input Voltage
0000 0000 0000	000	-5.0000 v (-Full Scale)
0000 0000 0001	001	-4.9976 v
.	.	.
0100 0000 0000	400	-2.5000 v (-½ Scale)

. . .	.	.
1000 0000 0000	800	±0 v (Zero)
1000 0000 0001	801	+0.0024 v
. . .	.	.
1100 0000 0000	C00	+2.5000 v (+½ Scale)
. . .	.	.
1111 1111 1111	FFF	+4.9976 v (+Full Scale)

### Thermosalinograph

PCPlus for Windows will work with the ODEC and Sea-Bird thermosalinographs. If a Sea-Bird thermosalinograph is used, the data coming from the Sea-Bird must go into another computer (COM1) running the SeaSoft software to convert the incoming frequencies into temperature and salinity, which is then shunted out COM2 into the PCPlus computer. The Sea-Bird thermosalinograph outputs its data in a ASCII frequency count representing multiple data values collected by the unit. The SeaSoft software will allow certain variables to be converted and sent to a second source (disk, serial port). PCPlus for Windows will not be able to handle the frequencies generated by the Sea-Bird thermosalinograph. An ODEC thermosalinograph automatically generates temperature and salinity (plus conductivity) values in ASCII format, thus the ODEC output can go directly to the PCPlus computer.

### CONCLUDING REMARKS

PCPlus for Windows is still being updated and refined. Further development in fault tolerance and alternate source input is currently the next phase of the program design. Alternate source input consists of automatically using a secondary source of vessel position data in case the primary input source is no longer sending data or is determined to be inaccurate. Also, a zoom option will be added to the map display for better visualization of a cruise track in a small region. The program currently accepts and displays data in the eastern Pacific. Future versions will allow for a user-defined region of the world to be viewed and sampled.

The program can also be used in fields other than ship-based data acquisition. The program is rigid in the type of data collected, but how the data are collected is fairly general. The program will always collect date, time, position, temperature, salinity, and fluorescence (new additions will always need to be coded), but the ports, speed, and location of data within a string can be changed at run-time. The program can be used as a monitor for temperature and salinity and/or discrete fluorescence in a lab where a real-time visual representation of the data is required. Due to the ease of design in

Visual Basic program, PCPluss for Windows could easily be adapted to any environment.

### ACKNOWLEDGEMENTS

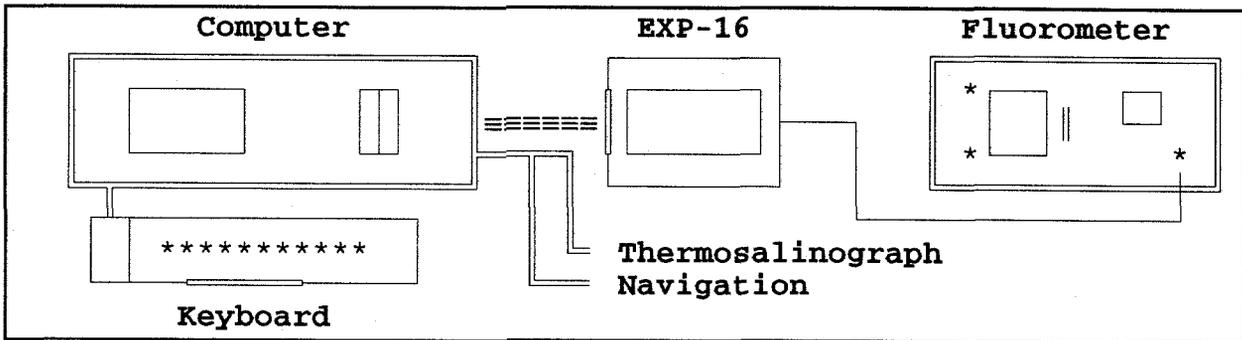
I would like to thank Dr. Stephen Reilly and Dr. Paul Fiedler for their guidance and insight into both the hardware and software aspects of this project. Their continued support motivated me to refine a simple data collection program to a robust data acquisition and real-time information display program.

I would also like to acknowledge Lisa J. Lierheimer and Valerie A. Philbrick. They provided suggestions for enhancing PCPluss to better accommodate anomalies that occurred at sea that could not be foreseen during testing.

### REFERENCES

Smith, R.C., K.S. Baker, and P. Dustan. 1981. Fluorometric techniques for the measurement of oceanic chlorophyll in the support of remote sensing. SIO Ref. 81-17, 14 pp.

## APPENDIX 1 - Specifications



**Figure 6**

**Table 2: Fluorometer**

Description	Pin	Voltage Range
Analog Output Signal	Pin M (w/ 1kΩ resistor)	0 - 1 Volt
Analog Range Output	Pin N (w/ 1kΩ resistor)	0.0v = x0 0.4v = x3.16 0.7v = x10 1.0v = x31.6
Analog Precision Ground	Pin L	
TTL x1/x100 knob	Pin S (w/ 1.1kΩ resistor)	0.0v = x100 0.5v = x1
TTL Return Ground	Pin D	

**Table 3: EXP-16 Multiplexer**

Input (Fluorometer)	Channel (EXP-16 Board)
Pin N	Channel 0 (hi)
Pin M	Channel 1 (hi)
Pin S	Channel 2 (hi)
Pin L	Channel 0 (lo) Channel 1 (lo)
Pin D	Channel 2 (lo)

- 1) 1k resistor across channel 0 (hi) and channel 0 (lo)    3) 1.1k resistor across channel 2 (hi) and channel 2 (lo)  
 2) 1k resistor across channel 1 (hi) and channel 1 (lo)    4) Toggle switch on gain control set to gain of 2

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